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Contents

Page

Foreword

This document prEN 15240 has been prepared by Technical Committee CEN/TC 156 “Ventilation for buildings”, the secretariat of which is held by BSI.

This document is currently submitted to the Formal Vote.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2002\91\EC.

Introduction

Article 9 of the Energy Performance of Buildings Directive (abbreviated as EPBD) requires the introduction of “measures to establish a regular inspection of air conditioning systems of an effective rated output of more than 12 kW”. The inspection is to include “an assessment of the air conditioning efficiency and the sizing compared to the cooling requirements of the building”. Advice is also to be provided to the users on “possible improvement or replacement of the air-conditioning system and on alternative solutions”. Therefore, it is not the intention to have a full audit of the air conditioning system but a correct assessment of its functioning and main impacts on energy consumption, and as a result determine any recommendations on improvement. The target groups of this standard are national regulators as well as the building services sector including professional building owners, and persons and organisations responsible for inspections.

Article 2 of the EPBD defines an “air conditioning system” as “a combination of all components required to provide a form of air treatment in which temperature is controlled or can be lowered, possibly in combination with the control of ventilation, humidity and air cleanliness.”

The inspection described here is therefore intended to include all types of comfort cooling and air conditioning systems that provide a total cooling output for the building above the specified 12 kW which is in turn taken to mean the rated cooling capacity of the included air conditioning systems The total cooling output of 12 kW is associated to a building or a zone of a building according to national regulations The term “air conditioning system” is used to represent any of the systems described below, which may heat and cool, and includes the associated water and air distribution and exhaust systems that form a necessary part of the system. It also includes the controls that are intended to regulate the use of these systems. It excludes mechanical ventilation systems that provide no mechanical cooling and components that, although they may be co-located in air conditioning systems, are dedicated to providing heating duty only. prEN 15239 gives details for inspection of ventilation systems, and of the associated air distribution and exhaust systems and thus provides complementary information to this standard. prEN 15378 specifies procedures and methods for the inspection of boilers and heating systems, according to Article 8 of the EPBD.

The possibility to introduce classes is given in this standard in order to leave Member States freedom to choose between different objects and extent of inspection, within a harmonised framework.

Air conditioning systems can be described according to the list of systems and subsystems presented in Annex A. Inspection classes can also be specified on national level. Examples of inspection classes are introduced in Annex B.

1 Scope

This European Standard describes the common methodology for inspection of air conditioning systems in buildings for space cooling and or heating from an energy consumption standpoint. The inspection can consider for instance the following points to assess the energy performance and proper sizing of the system:

— System conformity to the original and subsequent design modifications, actual requirements and the present state of the building.

— Correct system functioning.

— Function and settings of various controls.

— Function and fitting of the various components.

— Power input and the resulting energy output.

It is not intended that a full audit of the air conditioning system is carried out, but a correct assessment of its functioning and main impacts on energy consumption, and as a result determine any recommendations on improvement of the system or use of alternative solutions. National regulations and guidelines targeting energy efficiency and in line with the main objectives of this standard are also applicable.

NOTE Provision of adequate ventilation and system balancing are dealt with in prEN 15239

The qualification of the persons or organisation responsible for inspections is not covered by this standard, but the requirements for inspections are covered.

The frequency of the mandatory inspection is defined on national level. Features affecting the frequency and duration of inspection are introduced in Annex C.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 1886, *Ventilation for buildings — Air handling units — Mechanical performance*

EN 12792, *Ventilation for buildings — Symbols, terminology and graphical symbols*

EN 13779, *Ventilation for non-residential buildings — performance requirements for ventilation and room-conditioning systems*

EN 14511-1, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling — Part 1: Terms and definitions*

prEN 15378, *Heating systems for buildings - Inspection of boilers and heating systems*

prEN 15241, *Ventilation for buildings — Calculation methods for energy requirements due to ventilation-systems in buildings*

prEN 15232, *Calculation methods for energy Efficiency improvements by the application of integrated building automation systems* prEN 15239, *Inspection of Ventilation Systems*

3 Terms and definitions

For the purposes of this Standard, EN 12792 and EN 14511-1 together with the following definitions apply.

3.1
air conditioning system
a combination of all components required to provide a form of air treatment in which temperature is controlled, possibly in combination with the control of ventilation, humidity and air cleanliness

3.2
inspection
in the manner of this standard, inspection means to examine the air conditioning systems in buildings

3.3
air conditioning system control
the measures taken in ensuring the system operates in accordance with the design criteria. It may be a part of the building system control

3.4
commissioning
the sequence of events that ensure the building and its associated geating, ventilation and air conditioning systems are functioning in accordance with the design parameters

3.5
design criteria
a set of descriptions based on particular environmental elements such as indoor air quality, thermal and acoustical comfort, energy efficiency and the associated system controls to be used for assessing the plant operation

3.6
control parameters
the set values of the internal environmental conditions

3.7
design documentation
written descriptions of the essential design elements of the plant

3.8
Cooling energy distribution system (abbreviated CED-system)
Subsystem, where the cooling energy is transported and distributed from the CES-system to CEE-system by a distribution medium, inclusive control systems (examples for the distribution medium are air, water, refrigeration fluid)

3.9
Cooling energy emission system (abbreviated CEE-system)
Subsystem, where the cooling energy is emitted to the space (for example air outlets, fan coils, chilled ceiling, surface cooling) inclusive control systems

3.10
Cooling energy generation system (abbreviated CEG-system)
Subsystem, where the cooling energy is generated by refrigeration units (examples are chillers, absorber unit, heat pumps) inclusive control systems

3.11
Energy supply system (abbreviated ES-system)
System supplying the necessary energy to generate the CEG-system (examples are electricity, gas, solar) inclusive control systems

4 Inspection procedure

4.1 General

The inspection shall commence with examination of the relevant design and system documentation and visual checks as far as possible to ensure that the equipment described is present and according to system specification. If the documentation is not available, then an additional part of this procedure is to locate the equipment and assemble a minimum portfolio of relevant documentation.

For the minimum content for the information that should be available in readiness for the inspection, the list in Annex D may be used.

NOTE. For the inspection of air conditioning systems classes may be specified on national level, according to one or more of the following parameters:

- Usage of the air conditioned building
- Air conditioned area or volume
- Type of air conditioning system
- Nominal cooling capacity
- Annual running time
- Date of installation
- Legal requirements
- System documentation

If the inspection classes introduced in Annex B are used, then the different relevant parts of the inspection procedure can be established from the examples of procedures given in Annex F for a few sub-systems. Optional inspection items and/or measurement methods may be applied according the inspection class.

Comments on the frequency and scope of maintenance of the air conditioning systems shall be covered in relation to national requirements and good practice, e.g. industry guidelines, This, and the dates of most recent maintenance may be referred to during the ‘physical’ inspection.

Where there is clear evidence that a good practice program of maintenance is being carried out, then the inspection described in this standard may be simplified or reduced in accordance with the classification.

When checking the performance of different parts of an air-conditioning system, the measurement methods employed will assist subsequent follow-ups. To make this possible, the instructions for each measurement method shall be followed and the instruments for the measurements calibrated in accordance with the manufacturer's instructions.

Compare system sizes with likely loads. Annex F contains procedures for assessing whether refrigeration systems and air supply and extract systems are likely to be oversized.

Estimate the Specific Fan Power of the air movement systems whenever relevant, from the installed fan capacities and the flow rates, noted in the commissioning records.

4.2 Pre-inspection and document collection

4.2.1 Documents

4.2.1.1 General

Prior to inspection, where possible, the design criteria, system characteristics and the operational regime shall be determined. All available original documentation relating to the building and the installed systems shall be collected and assessed. Additional documentation, if it exists, indicating any modifications or alterations to the building, the systems or the use since the original documents, shall also be obtained and assessed. Annex D provides examples of documents needed.

4.2.1.2 Design documentation

Collect and identify available current relevant documents to support the inspection and the relevant subsystems and components.

If a satisfactory documentation is not available, a minimum set of information on the air conditioning system and building use shall be assembled.

The energy certificate, if available, shall be used.

Correspondence between documentation and actual installed components shall be checked. Any difference shall be stated in the report.

The design documents, where available, which define the relevant design criteria, shall be checked against the actual installation and the present use.

4.2.1.3 System characteristics.

Working or as installed drawings shall be checked against the actual installation and use of the building.

An equipment list shall be obtained or prepared.

If available, the commissioning data shall be checked against the present system.

4.2.1.4 Building and system operation and maintenance status.

Determine whether the air conditioning system, subsystems or components are regularly and correctly operated, and maintained by qualified and/or authorised personnel according to:

- System designer’s instructions
- Manufacturer’s instructions of the subsystems and components
- Any legal or statutory requirements

The maintenance status is an important part of the inspection Check the maintenance records for the system and for individual items of the system, as well as the building and system log book.

4.2.2 Building and system survey

Advise the user to keep and maintain any documentation determined above and any survey or calculations carried out during the initial (first) pre-inspection in a file so that they are available for subsequent inspections of the building and system(s).

4.2.3 Advice in case of outdated, incomplete or missing documentation

In existing buildings the design and system documentation may be incomplete or even missing. The existing documentation may be partly outdated, due to undocumented changes in the use, loads, construction elements or building services systems during the building's lifetime.

In these cases, the lacking or outdated documentation shall be identified (the checklists given in Annexes F and G may be used whenever relevant), and the organisation or person responsible for the inspection shall provide the user advice on how to develop a plan to complete the documentation.

4.3 Methodology

4.3.1 General

The inspection shall determine if the equipment operates in an appropriate environment and with acceptable efficiency and if maintenance and control checking operations are regularly carried out.

NOTE. Some of the checks and tests described here are obligatory in some countries, and may be done separately or in connection with the full inspection, and also more frequently than the full inspection if required. The inspection should take these into account as a part of the inspection if relevant.

NOTE. Annex F may be used as a default list for checks, further information and advice on items under 4.3.2…4.3.9.

4.3.2 Inspection of the refrigeration equipment

Check the refrigeration equipment.

NOTE. The checks would typically include the following items.

-refrigeration plant and its immediate surroundings

-compressors

-measurement records

-capability of providing cooling: operating temperatures, refrigerant charge, refrigerant leak

-insulation of refrigerant lines

-vibration and noise level

-condensing pressure

-efficiency data of the chillers

If any regulation requires periodic leak detection and repair, the documentation of the leak test shall be examined.

4.3.3 Inspection of pumps and chilled water pipe work

Check the condition and operation of chilled water pipe work and its insulation. A good insulation, especially on chilled water systems where lengths of chilled water lines can be considerable, can have a significant influence on the system energy efficiency of the system. Check for signs of leakage from the pipe work. Check the pumps and valves for the distribution of water as an energy carrier.

4.3.4 Inspection of effectiveness of outdoor heat rejection

Locate and check the condition and operation of the outdoor heat rejection units.

4.3.5 Inspection of the effectiveness of heat exchange to the refrigeration system (indoor units of split and distributed systems)

Check the condition and operation of heat exchangers inside those units installed within the treated spaces.

4.3.6 Inspection of air delivery systems in treated spaces

NOTE 4.3.6 to 4.3.8 are applied in cases where the air-conditioning system includes distribution of cooling energy using ventilation. See also prEN 15239.

In the treated indoor spaces, locate and check the air delivery openings, grilles or diffusers, and locate the route by which air is extracted from the spaces. Note if there is any evidence that occupants find the air delivery arrangement unacceptable. Assess the positioning and geometry of air supply openings in relation to extract openings, and the potential to short-circuit from supply to extract. .

4.3.7 Inspection of air delivery systems at air handling units and the associated ductwork

The air handling unit may have a warning sign affixed that indicates that the air handler fan should be turned off and air flow stopped before the air handler door is opened for inspection. If this is not present then the inspection shall include advice to affix such a warning. EN 1886 includes suggested wording for such a warning sign.

Determine and record the frequency of filter changing or cleaning, and the time elapsed since the last change or cleaning.

Assess the current state of cleanliness, damage or blockage of filters. Assess the condition of heat exchangers.

4.3.8 Inspection of air inlets to the system

Locate and check the air inlets to the system.

4.3.9 Inspection of the building system controls and control parameters

Identify and provide advice of all controls, sensors and indicators which are relevant for energy performance, as appropriate, on:

- location
- function
- settings

Locate and inspect the controls responsible for the operation of the air conditioning or comfort cooling system, the heating system controls, and their associated temperature sensors.

Review documentation or other sources of information to determine the individual control zones for heating and cooling. Determine the appropriateness of zoning in relation to factors such as local levels of internal gain, orientation and exposure to solar radiation.

Determine, where applicable, the method used to set, modulate or control air flow rate in the air supply, recirculation and exhaust ducts. Provide a view of the efficiency compared to good current practice.

4.3.10 Metering

Meters may have been installed to air conditioning systems, such as energy consumption or running time meters. Regularly noting the readings of such meters can help assess the operation of the air conditioning system.

Where energy consumption has been recorded on a regular basis, an estimate shall be done from the rated input power and the consumption record, whether the equipment is running in accordance with the use of the building. If not, the inspection shall include advice to the owner to reduce the energy consumption.

Where meters are installed, but no consumption records are available, the inspection shall include advice to record meter readings on a regular basis.

Where no such metering is in place, a part of the advice provided would be to install appropriate energy consumption metering at least to the more significant energy consuming air conditioning plant, and subsequently to record the consumption on a regular basis.

4.4 Reporting

A report of the air conditioning inspection shall be prepared.

The inspection report shall include at least the identification data of the property inspected and person and organisation in charge of the inspection, list of the relevant documents, and results of the inspection. One example of the list of the inspection report is given in Annex G.

The inspection report shall give an assessment of the total energy efficiency of the systems inspected.

5 Advice on alternative solutions and improvements

According to Article 9 of the EPBD, advice is to be provided to the users on “possible improvement or replacement of the air-conditioning system and on alternative solutions”.

As the pre-inspected and collected information, as well the inspection results are different according to the system, the advice vary regarding the improvements and alternative solutions.

The advice shall consider the main impacts for improvements:

- Adaptation to the actual use of the building
- Reduction of the cooling load
- Improvement of the maintenance
- Incorrect function of the system, the subsystems and components
- Replacement of the system, subsystems or components

NOTE. Alternative solutions may be necessary for such air conditioning systems which are far away from agreed reference values, like replacement of the whole system.

Detailed cost effectiveness studies are outside the scope of this assessment, but a number of opportunities may be considered worthwhile recommending for further study by specialists. These should generally include alterations that could be made at relatively low cost, particularly those that might be considered when older equipment is due for replacement. This will allow the loading on cooling equipment to be reduced or would increase the opportunity to make use of available solutions alternative to mechanical cooling, for at least part of the time.

NOTE. Annex H describes in more detail some of these issues. The checklists presented in annex F give also guidance on advice and recommendations.

Annex A
(informative)

Examples for the indication of subsystems of air conditioning systems

A.1 General

Air conditioning systems are varied and for the specification they should be split into the various subsystems. An indication of subsystems is written in A.2. The complete air conditioning system is the sum of the subsystems. Examples for classification of complete air conditioning systems are described in A.3

A.2 Indication for subsystems

Table A.1. Terms of subsystems

Subsystem	Main components	Term	Remarks
CEE-system	Air outlets	E.1	
	Fan coils	E.2	
	Cooling ceiling system	E.3	
	Surface cooling system	E.4	
	Heat exchangers for ventilation system	E.5	
	Air filter	E.6	
	Split unit evaporator	E.7	
	Optional	E.xx	
CED-system	Ventilation duct system	D.1	
	Water pipe system	D.2	
	Refrigeration pipe system	D.3	
	Optional	D.xx	
CEG-system	Chiller air-cooled	G.1	
	Chiller water-cooled	G.2	
	Split-unit condenser	G.3	
	Air-to-water heat pump	G.4	
	Water-to-water heat pump	G.5	
	Absorption system	G.6	
	Single-package system	G.7	
	Air-to-air heat pumps	G.8	
	Water-to-air heat pumps	G.9	
	Optional	G.xx	
ES-System	Electric supply system	S.1	

Table A.1. Terms of subsystems (concluded)

	Gas supply system	S.2	
	Solar energy supply system	S.3	
	District heat system	S.4	
	Optional	S.xx	

Advice: 1) More detailing of main components can be done by adding further numbers (e.g. G.xx) see term Gx.x.)

2) Missing main components can be added as optional.

A.3 Examples for classification of complete air conditioning systems

a) Single split room conditioner systems is classified as: E.7 + D.3 + G.3 + S.1

b) System with air cooled chiller and fan coils is classified as: E.2 + D.2 + G.1 + S.1

c) System with gas motor driven heat pump with surface cooling: E.4 + D.2 + G.5 + S.2

Annex B
(informative)

Examples of inspection classes of air conditioning systems

The inspection class can be determined according to different criteria, such as

-the type of the air conditioning system (generation and emission),

-the cooling capacity,

-the annual running time,

-the age of the installation,

-the use of the building (e.g. residential, office…)

-the location of the system (e.g. outdoor/indoor) and the building

-etc.

The following table gives an example how to classify the system inspection class.

Table B.1 Example of a classification system, with three inspection classes

Inspection class	Specification	Details	Dim.	Remarks
1	Nominal cooling capacity:	12,0 – 49,9	kW	
	Annual running time:	under 2000 *)	h/a	
	Date of installation:	less than 10	years	
2	Nominal cooling capacity:	50,0 – 399,9	kW	
	Annual running time:	up to 5000	h/a	
	Date of installation:	less than 15	years	
3	Nominal cooling capacity:	Above 400,0	kW	
	Annual running time:	up to 5000 **	h/a	
	Date of installation:	Less than 20	years	

*) summer cooling only

**) all year cooling

If one of the details is not fulfilled the inspection class is upgraded to the next higher class.

Annex C
(informative)

Features affecting the frequency and duration of inspection

The minimum contents and frequency of mandatory inspection is defined on national level, with a recommended default value of 5 years. On voluntary basis, more extensive and more frequent inspections are possible.

The inspection may be more or less frequent, depending on: type of building, energy impact of the system, type of equipment, quality of system documentation, availability of records of measurements and/or energy consumption metering, and quality of maintenance. For centralised systems for cooling and ventilation, different parts and system components may require more frequent checks, and in this case these records should be available for inspection.

After the initial inspection, the time for the next inspection may be longer or shorter depending on the results from the initial inspection and on the level of maintenance.

The inspection intervals recommended should be given on national level as tabled values and compared to the default frequency given above.

The outcome of the inspection will be to generate advice for the owner or manager to improve the system, or improve system maintenance. A part of that advice will be to recommend more frequent routine inspection and maintenance, for a good practice maintenance programme. The advice shall be integrated and balanced with other energy conservation recommendations.

The time taken for the inspection obviously depends on the size and age of the system, type of building, time since latest inspection, quality of documentation and maintenance of the systems installed. In many cases the required extent of the inspection can be estimated from the quality of system documentation (including balancing and maintenance records), checking of self-inspection records and a relatively short visual check. In the best cases these, if clearly give an impression of properly maintained systems and meeting the requirements of Article 9, may be sufficient without any need for further physical checks and measurements

The checklist given in annex F is suitable for a relatively "simple" inspection for a combined system. However, this inspection will not provide a complete picture of the system energy performance including the performance of controls.

Annex D
(informative)

Checklist of pre–inspection information

	Information needed	Present Y/N
1	Itemised list of installed air-conditioning systems, with. >12kW rated output for the building *), with locations of the indoor and outdoor components of each system. *) unless the 12 kW limit is specified otherwise on national level	
2	Description of system control zones.	
3	Description of method of control of temperature.	
4	Description of method of control of periods of operation.	
5	Maintenance plan and records of maintenance to refrigeration systems, including cleaning indoor and outdoor heat exchangers, refrigerant leakage tests, repairs to refrigeration components or replenishing with refrigerant.	
6	Maintenance plan, and records of maintenance to air delivery systems, including filter cleaning and changing, and cleaning of heat exchangers.	
7	Records of calibration and maintenance operations carried out on building automation and control systems and sensors, or building management systems and sensors.	
8	For relevant air supply and extract systems, commissioning results of measured absorbed power at normal air delivery and extract air rates and commissioning results for normal delivered delivery and extract air flow rates (or independently calculated Specific Fan Power for the systems).	
9	An estimate of the design cooling load for each system (if available). Otherwise, a brief description of the occupation of the cooled spaces, and of power consuming equipment normally used in those spaces.	
10	Energy consumption counters; location, target values for consumption, records of consumption, compared measured vs. target consumption	
11	Records of any issues or complaints that have been raised concerning the indoor comfort conditions achieved in the indoor spaces.	
12	Where a Building Management System (BMS) is used, a statement describing its capabilities, the plant it is connected to control, the set points for the control of temperature, the frequency with which it is maintained, and the date of the last inspection and maintenance. See also prEN 15232	
13	Where a monitoring station, or remote monitoring facility, is used to continually observe the performance of equipment such as chillers, a statement describing the parameters monitored, and a statement reviewing the operating efficiency of the equipment.	

Annex E
(informative)

Recommendations for the extent of the inspection

E.1 General

The list according E.2 describes an example of the minimum recommended extent for inspection. The extent may be different for different inspection classes. In the following example of E.2, the recommended extent for three different classes (C for low level, B for medium level, A for high level) are given for a few subsystems defined in Annex A. Additional classes and features for the inspection are possible.

E.2 List of items for inspection in each class (C, B, A)

DOCUMENTATION					
No.	**Item**	**Details**	**C**	**B**	**A**
C.1.1	Inspection class determined	O O 1 O 2 O 3 O	x	x	x
C.2.1	State of the building design documentation	No O not complete O complete O	x	x	x
C.2.2	Missing parts	…………………………………………		x	x
C.3.1	Air conditioning system design documentation	No O not complete O complete O	x	x	x
C.3.2	Missing parts	…………………………………………..		x	x
C.4.1	Cooling load estimated	…………kW	x		
C.4.2	calculated	…………kW		x	x
C.5	Air conditioned building volume	………….. m^3	x	x	x
C.6.1	Operation mode	free cooling O outdoor cooling O recirculation air cooling O	x	x	x
C.6.2	Mode of running operation	………h			x
	Optional				

BUILDING					
No.	**Item**	**Details**	**C**	**B**	**A**
B.1	Address	……………………………………….	x	x	x
B.2	Location	………………………………………	x	x	x
B.3	User name	……………………………………….	x	x	x
B.4	User address	……………………………………….	x	x	x
B.5	Responsible person	……………………………………….	x	x	x
B.6	Building / zone type	space O office O hotel O factory O service appliances O ……………………………………… ………………………………………	x	x	x
B.7	Date	erection …………changes …………..	x	x	x
B.8	Relevant changes building	………………………………………..			
B.9	Usage	residential O non residential O	x	x	x
B.10	Air conditioned volume	…………… m^3	x	x	x
B.11	Required services	humification O dehumification O cooling O	x	x	x
B.12	Required values	indoor air temperature …………º indoor humidity …………%.	x	x	X
B.13	Building mass specification	heavy O middle O low O		x	x
B.14.1	Sun radiation protection	No O Yes O	x	x	x
B.14.2	type	………………………………………		x	x
B.14.3	shielding factor	……………		x	X
B.14.4	function correct	No O Yes O	x	x	x
B.15.1	Internal load persons	No O Yes O	x	x	x
B.15.2	number of persons	………………………………………		x	x
B.15.3	relevant appliances	No O Yes O type ………………..		x	x
B.15.4	total internal load:	……………kW		x	x
B.16.1	External load outdoor air	.. …………kW	x	x	x
B.16.2	recirculation air	……..……. kW	x	x	x
B.16.3	cooled appliances	No O Yes O type ……..………..	x	x	x
B.16.4	appliances load	…………kW	x	x	x
	Optional				

CEE-SYSTEMS (cooling energy emission) – example: fan coils					
No.	**Item**	**Details**	**C**	**B**	**A**
E.2.1.1	Documentation	No O not complete O complete O	x	x	x
E.2.1.2	missing parts	…………………………………………		x	x
E.2.2	Number/type	…………………………………………	x	x	x
E.2.3	Total air flow	…………m^3/s		x	x
E.2.4	Total cooling capacity	………… kW	x	x	x
E.2.5.1	Running time estimated	..……..…h/a	x		
E.2.5.2.	measured	……… …h/a		x	x
E.2.6.1	Total fan power calculated	………… kW	x	x	
E.2,6.2.	measured	………… kW			x
E.2.7	Specific fan power	..………. kW/m^3/s			x
E.2.8	Maintenance state	Regular O on demand O No O	x	x	x
E.2.9	State of operation	satisfied O not satisfied O	x	x	x
E.2.10.1	Control system	No O Yes O type ………………….	x	x	x
E.2.10.2	setting	satisfied O not satisfied O		x	x
.	Optional				

CEE-SYSTEMS – example: Split unit room conditioner					
No.	**Item**	**Details**	**C**	**B**	**A**
E.7.1.1	Documentation	No O not complete O complete O	x	x	x
E.7.1.2	missing parts	………………………………………		x	x
E.7.2	Type/ Specification	………………………………………	x	x	x
E.7.3	Total air flow	…………m^3/s		x	x
E.7.4	Total cooling capacity	…………kW		x	x
E.7.5.1	Running time estimated	…………h/a	x		
E.7.5.2	measured	…………h/a		x	x
E.7.6.1	Total fan power calculated	..……… .kW	x		
E.7.6.2	measured	…………kW		X	x
E.7.7	Specific fan power	……….. .kW/m3/s	x	x	x
E.7.8.1	Control system	No O Yes O type ………………	x	x	x
E.7.8.2	setting	satisfied O not satisfied O		x	x
E.7.9	Maintenance state	regular O on demand O No O	x	x	x
E.7.10	State of operation	satisfied O not satisfied O	x	x	x
	Optional				

CED-SYSTEM (cooling energy distribution)-example: Water pipe system					
No.	**Item**	**Details**	**C**	**B**	**A**
D.2.1.1	Documentation	No O not complete O complete O	x	x	x
D.2.1.2	missing parts	………………………………………		x	x
D.2.2	Tightness	visual satisfied O not satisfied O	x	x	x
D.2.3.1	Isolation	visual satisfied O not satisfied O	x	x	x
D.2.3.2	surface temperature	measured……..ºC		x	x
D.2.4	Condensation outside	No O Yes O	x	x	x
D.2.5.1	Water flow calculated	………. m^3/s	x		
D.2.5.2.	measured	………. m^3/s		x	x
D.2.6.1	Pressure drop calculated	………. Pa	x		
D.2.6.2	measured	………. Pa		x	x
D.2.7	Temperatures	supply ……… ºC return ……… ºC	x	x	x
D.2.8	Number cooling circles	……………………………………….	x	x	x
D.2.9	Labelling	Yes O No O necessary O	x	x	x
D.2.10.1	Isolation piping	visual satisfied O not satisfied O	x	x	x
D.2.10.2	armatures	visual satisfied O not satisfied O	x	x	x
D.2.11	Condensation outside	No O Yes O	x	x	x
D.2.12.1	Circulating pump number	…………………………….		x	x
D.2.12.2	type	…………………………….		x	x
D.2.12.3	total nominal power	…………kW		x	x
D.2.13	Total water flow	………… m^3/s		x	x
D.2.14	Pressure drop	…………Pa		x	x
D.2.15	Running mode	modulating O on demand O	x	x	x
.	Optional				

CEG-SYSTEM (cooling energy generation) – example: Chiller air-cooled					
No.	**Item**	**Details**	**C**	**B**	**A**
G.1.1.1	Documentation	No O not complete O complete O	x	x	x
G.1.1.2	missing parts	………………………………………		x	x
G.1.2	Type of thermodynamic system	Compressor O Ab(Ad)sorber	x	x	x
G.1.3	Type of refrigeration fluid	………………………………………	x	x	x
G.1.4	COP calculated	…………	x	x	x
G.1.5	Running time estimated	…………h/a	x		
G.1.5.1	measured	…………h/a		x	x
G.1.6	Condenser type	? O ? O	x	x	x
G.1.7.1	Fan power measured	…………h/a	x		
G.1.7.2	calculated	………. kW		x	x
G.1.8	Total air flow	. ……….. m^3/s		x	x
G.1.9	Specific fan power	value …………..$kW/m^3/s$			x
G.1.10.1	Storage tank	No O Yes O	x	x	x
G.1.10.2	volume	………….m3	x	x	x
G.1.10.3	Isolation	visual satisfied O not satisfied O	x	x	x
G.1.10.4	Surface temperature	measured…..ºC			x
G.1.11	Total cooling capacity	………… kW	x	x	x
G.1.12.1	Control system	No O Yes O type ………………	x	x	x
G.1.12.2	setting	satisfied O not satisfied O		x	x
G.13	Maintenance state	regular O on demand O No O	x	x	x
G.14	State of operation	satisfied O not satisfied O	x	x	x
	Optional				

CEG-SYSTEM-example: Split unit condenser					
No.	**Item**	**Details**	**C**	**B**	**A**
G.3.1.1	Documentation	No O not complete O complete O	x	x	x
G.3.1.2	missing parts	………………………………………………		x	x
G.3.2	Type	Single split unit O Multi split unit	x	x	x
G.3.3	Condenser location	indoor O outdoor O	x	x	x
G.3.4	Supply of outdoor air	satisfied O not satisfied O	x	x	x
G.3.5	Total cooling capacity	…………kW	x	x	x
G.3.6	COP calculated	…………		x	x
G.3.7.1	Running time estimated	…………h/a	x		
G.3.7.2	measured	…………h/a		x	x
G.3.8	Total power specific value	…………kW/m^3/s			x
G.3.9	Maintenance state	regular O on demand O No O	x	x	x
G.3.10	State of operation	satisfied O not satisfied O	x	x	x
G.3.11.1	Control system	No O Yes O type …………………	x	x	x
G.3.11.2	setting	satisfied O not satisfied O		x	x
	Optional				

ES-SYSTEM (Energy supply)– example: Electric supply system					
No.	**Item**	**Details**	**C**	**B**	**A**
S.1.1.1	Documentation	No O not complete O complete O	x	x	x
S.1.1.2	missing parts	……………………………………………		x	x
S.1.2	Voltage		x	x	x
S.1.3	Starting power requirement	Available O necessary O	x	x	x
S.1.4	Measuring appliance	Available No O Yes O	x	x	x
S.1.5	Counting appliances available	Available No O Yes O	x	x	x
	Optional				

Annex F
(informative)

Examples of checklists indicating observations and appropriate actions or advice

1. Checklist for design and system documentation (4.2)

	Assessment topic	Notes and advice
1.1	Review available documentation	If missing or unsatisfactory (see Annex D) then certain basic information will need to be prepared
1.2	Locate relevant plant and compare details	Prepare revised information as necessary
1.3	Review current inspection and maintenance regime	Be sure of availability in the documentation of manufacturers maintenance books for components are available, and provisions have been followed
1.4	Compare system size with imposed cooling loads	If oversized, recommend further investigation or replacement when appropriate
1.5	Estimate Specific Fan Power of relevant air movement systems	If commissioning air flow and fan power rates are not available, recommend that these are measured and compared to current recommendations (see EN 13779), if higher than recommended then seek for the reason during inspection
1.6	Ask the user/owner of the building if any complains of the indoor climate have repeatedly appeared	Check the reasons for repeated complaints. Ask the user/owner to pay attention to complaints if repeated

2. Checklist for refrigeration equipment (4.3.2)

	Assessment topic	Notes and advice
2.1	Visual appearance of refrigeration plant and immediate surrounding area	Note whether the plant appears clean and unobstructed. If dirty and cluttered, then regular inspection and maintenance is unlikely and this should be noted. Visual signs of refrigerant leakage should be noted and, if present, evidence of attention to any leakage sought. If this has not been attended to, then recommend prompt skilled maintenance.
2.2	Locate refrigeration plant and check operation	Note whether there are any discrepancies between actual and documented plant. Note whether plant is operational

2.3	Availability of measurement records	If available, use the records for checking of the functioning of the equipment. If not, then recommend measurements and proper documentation of — suction and discharge pressure of compressor(s) — refrigerant temperature at the inlet of the compressor / outlet of evaporator — power input to the equipment Generally these measurements are available on large units, either on the unit or via the system management for default detection.
2.4	Check that refrigeration plant is capable of providing cooling by assessing temperature difference, and observing the refrigerant sight glass (where readily visible). Observe refrigerant charge and check visually possible refrigerant leak	Note where plant appears to contain no, or insufficient, refrigerant and recommend prompt skilled maintenance. Charge is OK if ahead expansion device liquid sight glass is clear and subcooling is at least 5°C
2.5	Insulation of refrigerant lines	Check the insulation of the refrigeration lines (especially with long runs) and recommend correct thermal insulation with vapour barrier if missing
2.6	Vibration and noise level	If any high levels occur, recommend specialist check and repair
2.7	Condensing pressure	Check if condensing pressure control is set for the best energy performance. Floating condensing temperature offers significant performance for energy saving
2.8	Efficiency data for chillers	Determine the efficiency data of the manufacturer of the chiller and compare these with the performance of the latest new chillers. Use this information to estimate the improvement of the efficiency of the chiller by replacement.

3. Checklist for pipe work including insulation (4.3.3)

	Assessment topic	**Notes and advice**
3.1	Check the condition, insulation and operation of chilled water pipe work. Check for signs of leakage from the pipe work.	If leakage detected, note whether they come from the pipe work directly or are due to condensation from not adequately insulated lines.

4. Checklist for outdoor heat rejection equipment (4.3.4)

	Assessment topic	Notes and advice
4.1	Visual check of the condition and operation of outdoor heat rejection units.	Note whether units have adequate free access to outdoor air. Recommend removal of debris, or increasing openings in enclosures, as appropriate.
4.2	Check for obstructions to airflow through heat rejection heat exchangers.	Recommend cleaning or repair as appropriate.
4.3	Check for signs of refrigerant leakage.	Visual signs of refrigerant leakage should be noted and, if present, evidence of attention to any leakage sought. If this has not been attended to, then recommend prompt skilled maintenance.
4.4	Check for the correct rotation of fans. If possible, observe the modulation of multiple fans in response to load changes.	Note whether fan rotates in the correct direction, and whether speed control is operational. If incorrect or defective, recommend skilled rectification or maintenance.

5. Checklist for effectiveness of heat exchange to the refrigeration system indoor units of split and distributed systems (4.3.5)

	Assessment topic	Notes and advice
5.1	Visually check the condition and operation of indoor units.	Note whether units have adequate free access to indoor air. Recommend removal of debris or blockage as appropriate.
4.2	Check air inlets and outlets for obstruction.	Note whether units have adequate free access to indoor air. Recommend removal of debris or blockage as appropriate.
4.3	Check for obstructions to airflow through heat exchangers.	Recommend cleaning or repair as appropriate.
4.4	Check the current status and quality of intake air filters.	Recommend cleaning or replacement as appropriate.
4.5	Check for signs of refrigerant leakage.	Visual signs of refrigerant leakage should be noted and, if present, evidence of attention to any leakage sought. If this has not been attended to, then recommend prompt skilled maintenance.
4.6	Check for the correct rotation of fans. If possible, observe any facility to modulate their speed in response to load changes.	Note whether fans rotate in the correct sense, and whether speed control is operational. If incorrect or defective, recommend skilled rectification or maintenance.

5. Checklist for air delivery systems in treated indoor spaces (4.3.6)

	Assessment topic	Notes and advice
5.1	Review air delivery openings, grilles or diffusers, and route by which air is extracted from the spaces. Review any evidence that occupants repeatedly find the air delivery arrangement unacceptable	If evidence of problems exists, recommend more detailed assessment by ventilation specialist.
5.2	Assess the positioning and geometry of air supply openings in relation to extract openings	Note where there may be potential that air might short-circuit from supply to extract. If suspected, this might be checked visually using a smoke-tracer.

6. Checklist for air delivery systems in air handling units and associated ductwork (4.3.7)

	Assessment topic	Notes and advice
6.1	Review filter changing or cleaning frequency.	Recommend adopting good practice industry guidance on cleaning and replacement if not in place.
6.2	Assess the current state of cleanliness or blockage of filters.	Recommend replacement if appropriate, and adopting good practice industry guidance on cleaning and replacement.
6.3	Note the condition of filter differential pressure gauge.	Recommend rectification if inoperable.
6.4	Assess the fit and sealing of filters and housings.	Recommend skilled maintenance if visibly poorly fitted.
6.5	Inspect heat exchangers for damage, or significant blockage by debris or dust.	Recommend cleaning or skilled maintenance as appropriate.
6.6	In addition inspect refrigeration heat exchangers for signs of refrigerant leakage.	Visual signs of refrigerant leakage should be noted and, if present, evidence of attention to any leakage sought. If this has not been attended to, then recommend prompt skilled maintenance.
6.7	Note fan type and method of air speed control.	Compare with current good practice and identify opportunities for improvement.
6.8	Inspect humidification, wet sections and drain pan for rust, deposits and piping clogging.	Recommend cleaning and restore as appropriate

7. Checklist for outdoor air inlets (4.3.8)

	Assessment topic	Notes and advice
7.1	Check for obstructions or blockages to inlet grilles, screens and pre-filters.	Recommend clearing of debris or cleaning as appropriate.
7.2	Check location of inlets for proximity to local sources of heat, or to air exhausts.	Comment on location of air inlets and recommend seeking skilled advice if these appear compromised.

8. Checklist for building system controls and control parameters (4.3.9)

	Assessment topic	Notes and advice
8.1	Assess zoning in relation to factors such as local levels of internal gain, orientation and exposure to solar radiation.	Comment on appropriateness of zoning and recommend further investigation if unclear and specialist advice if inappropriate. Assess zoning regarding to operating schedules Analyse the possibility to move form zone control towards room by room control
8.2	Note the current indicated weekday and time of day on controllers against the actual time.	Recommend resetting if incorrect.
8.3	Note the set on and off periods (for weekday and weekend if this facility is available with the timer).	Note any shortfall in the control timer capabilities, and recommend resetting if unsuitably set.
8.4	Identify and assess zone heating and cooling temperature control sensors.	Note the appropriateness of the type and location of sensors in relation to the heating and cooling emitters, heat flows or likely temperature distributions in the zone or space, and the intended function of the sensors. Recommend further investigation if uncertain, and specialist advice if inappropriate.
8.5	Note the temperature set-points in each zone for heating and cooling in relation to the activities and occupancy of the zones and spaces, in relation to the manager's intent.	Note the suitability of the temperature set-points and recommend re-setting as appropriate. Recommend further investigation if uncertain.
8.6	Note whether a 'dead band' is or can be set between heating and cooling.	Recommend resetting as appropriate. Recommend further investigation if unclear. Recommend to install an interlock between the controllers for heating and cooling when appropriate
8.7	Assess the refrigeration compressor(s) and the method of refrigeration capacity control.	Provide a view of the efficiency compared to good current practice, and recommend further investigation if there appears to be significant potential for improvement.

8.8	Assess means of modulating or controlling air flow rate through air supply and exhaust ducts.	Provide a view of the likely efficiency compared to good current practice, including: — time/occupancy /IAQ (Indoor Air Quality) control of air flow rate; — use of air flow rate for night ventilation or free cooling; control of heat recovery according to heating/cooling needs Recommend further investigation if there appears to be significant potential for improvement.

Annex G
(informative)

Inspection report, example of contents

Details of the property inspected, and the person or organisation responsible for inspection:

— The address, name, or other unique identifier of the property.

— The owner or manager of the building.

— The date of the inspection.

— The organisation and person responsible for inspection: name, address, contact information and status (e.g. Approved by 'xxxxxxx' accreditation body).

List of the documents provided

— Documentation of the systems

— Documents for operation and maintenance of the system

Details of the systems inspected:

— Physical descriptions of the systems inspected.

— The inventory of equipment inspected and their locations.

Details of the results of the inspection:

— The results of any measurements or calculations reviewed or made for the inspection (including reporting about the measurements and measuring methods and instruments – uncertainty, calibration).

— Overall energy use and energy efficiency of the system -conclusive parameters to be presented when applicable:

  — specific fan power (SFP) and hours of operation;

  — heat or cooling load;

  — energy use for heating of supply air *(including control)*;

  — energy use for cooling of supply air *(including control)*;

  — performance of heat recovery devices and the performance of the system regarding desired and achieved indoor air quality by parameters such as: airflow rates, draught, CO_2 concentration in occupied zones and noise levels .

  — energy use for pumps

  — energy use for other cooling loads (chilled beams)

  — heat or cooling capacity

Efficiency of the refrigeration system

- Comments on the likely efficiency of the installation and any suggestions made for improvement
- Comments on any faults identified during the inspection and suggested actions
- Comments on the adequacy of equipment maintenance and any suggestions made for improvement
- Comments on the adequacy of installed controls and control settings and any suggestions made for improvement
- Comments on the size of the installed system in relation to the cooling load and any suggestions for improvement
- Comments concerning alternative solutions
- Summary of the findings and recommendations of the inspection

Annex H
(informative)

Energy impacts of air conditioning, justification of inspection and improvements

H.1 General

Saving energy for air conditioning (cooling mode) is be based on the following:

1) Reduction of the cooling needs of the building
2) improving the system efficiency on the various stages :
    a. emission
    b. distribution
    c. generation.
    d. storage

According to Article 9 of the EPBD, advice is also to be provided to the users on “possible improvement or replacement of the air-conditioning system and on alternative solutions”.

In the inspection, attention should be paid also on the possibilities to save energy by other measures than those related to the system. Recommendations should, whenever appropriate, pay attention to these issues. This annex will address mainly the cooling issues. The lists of measures are not exhaustive, and the applicability of the measures depends on climatic and other local conditions. Ventilation issues are presented in prEN 15239, and heating issues in prEN 15378.

H.2 Reduce cooling needs of the building

This can be achieved as follows:

Reduce solar gains through windows: the best solution is windows to have moveable outdoor screens, which provide control of lighting intensity, glare and solar gains according to outdoor conditions. For some case, high rise buildings for example, solar glazing can also be used for windows, but the overall efficiency shall be checked (impact on heating, cooling and lighting). Automatically controlled shading can significant lower the cooling load during and after times of user absence.

In general, windows are sufficiently insulated for winter and no additional insulation is required for cooling. If some envelope components are not insulated, there will be a benefit also for cooling, especially for the roofs.

Thermal mass – orientation – other structural means: these apply to new buildings only, possibilities in existing buildings very limited.

Reduce internal gains

Artificial lighting is an important heat source. Installing high efficiency lamps and improved control will reduce the energy both for lighting and for cooling. Choosing energy efficient equipment (as computers for example) shall also be considered.

H.3 Improve the system efficiency

Use outdoor air when beneficial

A building may be cooled when the outdoor temperature is lower than indoor temperature. Increasing the ventilation rates is beneficial to reduce the cooling load – however, fan energy shall be taken into account.

For balanced system, it is also possible either to stop or bypass the heat exchanger, or for systems using also secondary air, to use 100 % of outdoor air, when beneficial.

Outdoor air flows should be reduced to the minimum hygienic value when its temperature is higher than the indoor air temperature during building cooling, taking into account the off-set by dissipation of fan energy in the air supply system.

Improve the emission efficiency

The aim is to provide the required amount of cooling where and when it is required.

This can be achieved by:

— Improving the local control efficiency.

— Avoiding cooling at indoor temperature lower than about 25 °C.

— Stopping cooling (and local fans) during unoccupied period (it can be restarted before occupancy period).

— Lowering latent energy by increasing the cooling coil temperature.

— Avoiding simultaneous cooling and heating, which is energy wasting (for example central cooling + local reheating; or mixing heated and cooled air). For the same reason if cooling and heating are achieved by separated devices, the controls should be set **to prevent any cooling and heating occurring at the same time**. This addition of heating and cooling can occur due to failure in the system and its controls, so special attention shall be paid on checking the set points of heating and cooling controls.

Improve the distribution efficiency

For existing buildings, this can be achieved by:

— Increasing the thermal insulation on pipe work.

— Increasing the chilled water temperature when possible.

— Reducing the energy required by the pumps (stop during unoccupied period or when cooling is not required; use of variable speed motors).

Improve the generation efficiency

Generation efficiency depends on the installed system characteristics as well as its control method.

An important issue to be considered is the impact of part load behaviour which generally reduce the efficiency: the correct system sizing is the first point to check. Cooling systems are often oversized, reducing their performance, even for systems which are efficient at full load. This shall also be considered if the solar and internal gains are reduced.

An alternative or additional measure to reduce part load behaviour is to install a water storage tank between the distribution network and the generation system.

As for emission and distribution, the generation system should be closed off when the building requires no cooling.

The generation efficiency depends on the maintenance quality (for example lack of refrigerant).

Checks for existing buildings/installations

The reasons for poor results can be due to deficient design or installation, failures after construction, or modifications by the staff, often not properly documented.

Initial design: Documents should be available and completed including changes during the design/installation process to verify the design requirements.

Installation and initial fine tuning: Functional performances testing.

Failures in the system; incorrect changes in fine tuning

Fault detection diagnosis can be performed at different levels of accuracy. One major point in the follow-up of time variation in energy use (for example, use of heat in summer for other than domestic hot water).

Building optimization: Adaptation to changes in building uses or modifications.

Advice on alternative solutions and improvements

Cooling load reduction

The effects of reducing cooling loads are not straightforward as there can be instances where reducing the load on plant could reduce efficiency and might also have an adverse effect on the reliability and life of the refrigeration plant. It will be more effective where equipment is inherently able to operate reliably and efficiently at reduced loading either as a result of its type and form of capacity control, or in modular systems comprising multiple compressors. The worst situation could be where cooling is provided by an older individual unit with only simple on/off control. However, there will also be instances where reducing cooling loads may allow mechanical cooling systems to be turned off altogether for longer periods of the year.

Cooling loads generally are influenced by:

— Solar gains from glazing.

— Heat gains from artificial lighting.

— Heat gains from the occupants.

— Heat gains from IT and other equipment.

— Heat gains from ventilation air.

Provided the air conditioning system is considered suitable to benefit from the reduction of cooling load, then opportunities should specifically be sought in each of these areas:

Solar shading, fixed or movable

South facing glazing makes a significant, and in some cases the largest, contribution to cooling load, particularly in perimeter spaces where glazing areas exceed 40%. Internal blinds have limited effect in reducing such gains, which are better treated by the use of overhangs or external shading. Treatments that could produce a darkened indoor environment should not generally be recommended as these may also increase the use of artificial light and thus fail to reduce the cooling load.

Higher efficiency, better controlled, lighting

Older lighting systems may be relatively inefficient and may also provide higher illumination levels than are recommended in current guidance. Such systems may contribute a significant proportion of the cooling load, and could be improved relatively easily. The appropriateness of illumination levels can be simply measured using a Lux meter. The type of lamp and luminaire predominantly in use should also be identified, and the efficiency compared with the current guidance. Switching and lighting control arrangements should also be assessed and compared with current guidance, as there may be significant opportunities to reduce average loads through localised switching and/or occupancy or daylight level controls.

IT equipment energy

Where IT and other equipment is relatively old, and replacement is being considered for, the opportunity should be taken to replace with low energy equipment. Much IT equipment such as PC screens, printers and copiers are available with a low energy 'sleep' facility to reduce energy use, and the heat gains, when not in use for significant periods.

Co-location and separate treatment of shared equipment

There may be opportunities to reposition of certain heat generating equipment, such as printers and copiers, away from the general work areas into separate rooms where the heat gains may be dealt with either by the use of opening windows or by providing simple extract ventilation.

Ventilation air

The suitability of the ventilation air flow rate provided by mechanical systems is addressed in prEN 15239. The inspection should note that providing significantly more ventilation air than necessary during hot weather would increase loading on cooling systems. Where cooling systems are used in spaces with access to opening windows, it should be ensured that the building owner or manager is made aware that windows should normally be closed (although trickle vents should be open as necessary) when the cooling equipment is in use, and the effect that opening windows would have on energy use. The manager should be advised to ensure that occupants are made aware of this need, or to consider installing interlocks between windows and cooling equipment in the associated spaces.

Alternative cooling techniques

Free cooling

Larger, centralised, systems using cooling towers may be suitable for conversion to apply free cooling techniques for some proportion of the time. In mid-season conditions, such as in spring and autumn, air temperatures may be sufficiently low that heat may be rejected from the chilled water circuit to atmosphere, through the cooling tower, without operating mechanical cooling plant. This involves the introduction of an intermediary heat exchanger to the chilled water circuit, transferring heat to a separate water circuit which rejects heat through the cooling tower.

Absorption cooling with CHP

Where buildings are provided with combined heat and power (CHP) systems to generate electricity and to service winter heating loads, and where "waste heat" temperatures are suitable, there may be opportunities to employ absorption cycle refrigeration systems. These make use of the heat generated by the CHP plant in summer, when there is no or little heat demand, to provide cooling. This would offset the use of electric vapour compression refrigeration systems and may increase the proportion of the year where the CHP might usefully be operated.